

CLIMATE CHANGE AND ECOLOGICAL HEALTH

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ABSTRACT

This paper provides an ecological health perspective on climate change. Human, wildlife, and ecosystem health all are interrelated, and all are under siege in the context of climate change. The “dirty energy” economy largely driving climate change is a major health threat. Climate change itself has even more serious implications for ecological health. Funders have diverse opportunities to work strategically at these intersections, using climate-health links to engage diverse constituencies, build partnerships, and support effective action. Some of the best strategies to address climate change are, in essence, strategies to protect human and ecological health.

INTRODUCTION: AN ECOLOGICAL HEALTH PERSPECTIVE

Contemporary society is organized as though humans somehow live “on top” of the natural world, safely taking from it what they need and discarding what they don’t. Many scientific disciplines are illuminating with hard data a quite different understanding – and one long held by religious traditions and indigenous cultures – namely that humans are biological beings, inextricably embedded within the natural environment. Air, water, food, bacteria, viruses, chemicals, weather, and pollutants are just a few of the myriad connections among Earth’s inhabitants.

The Intergovernmental Panel on Climate Change (IPCC) is the international body charged by governments with assessing the most credible scientific research on climate change from many disciplines and countries. IPCC is reporting more and more hard evidence that humans are profoundly affecting natural systems, and that these changes are having profound impacts on humans and wildlife. “This ecological perspective recognizes that the foundations of long-term good health lie in the continued stability and functioning of the biosphere’s natural systems – often referred to as ‘life-support systems.’”¹



Conservation Medicine: Ecological Health in Practice. Oxford University Press, New York.

This science-based ecological health perspective thus recognizes that the health of ecosystems, humans, and (non-human) animals are profoundly interconnected.² This perspective helps us understand climate change and its relevance to diverse grantmakers, especially to those focused on protecting human health or that of wildlife and their habitats. Understanding the linkages among these seemingly disconnected arenas reveals broadly shared stakes in the problem of climate change and highlights the shared opportunity for solutions. At the points of connection lie many of the elements needed to mobilize the will, resources, strategies, and partnerships for effective action for the good of both climate and health.

Climate Change as an Environmental Problem. Climate change may be the greatest environmental challenge of this generation. Past debates over *whether* climate change is occurring have been overtaken by broad scientific consensus that very serious human-caused climate changes are taking place. These changes have far-reaching consequences, linked to altered global and regional temperatures, melting glaciers, rising sea levels, intense weather events, and massive losses of biological diversity.³

Climate as a Health Problem. Global climate change is increasingly also understood as a major public health challenge for this generation. It will be an even greater one for future generations. Simply put, what is harmful to the earth's climatic systems is harmful to many of earth's inhabitants as well. The forces *driving* climate change are already causing massive adverse health effects on humans, wildlife, and ecosystems. The complex *system upheavals* caused by climate change represent even more profound threats to health.

This paper seeks to introduce funders to this critical area of work and to highlight potential entry points for intervention. It focuses primarily on human and wildlife health; others in this series detail links between climate change and the health of marine or terrestrial ecosystems. (Likewise, though climate is an inherently global problem, this paper uses mostly US data only for reasons of audience and because the US is such a disproportionate emitter of global greenhouse gas emissions.)

HEALTH AND THE FORCES DRIVING CLIMATE CHANGE

Climate changes have occurred in other periods of history, driven by natural forces. Climate change in the 21st Century is being driven primarily by “anthropogenic” (human-made) forces, particularly the combustion of fossil fuels. Burning coal, oil and gas produces carbon dioxide (CO₂), the leading greenhouse gas responsible for about two-thirds of global warming to date.⁴ Fossil fuel combustion also produces other pollutants like soot (“black carbon”), ozone, and methane. The cumulative impacts of these pollutants on the climate roughly equal that of CO₂. Other important drivers of climate change include non-carbon aerosols, land use changes and deforestation.⁵

Each driver of climate change has health consequences, not all of them adverse. Energy use is a perfect example. There are vast benefits from energy. It fuels our cars and trucks, powers factories, heats and lights our homes, schools, hospitals, and businesses. Using fossil fuels for energy, however, has led to massive and mounting ecological costs. This “dirty energy” yields both local and global impacts in the form of increased air pollutants and global warming. Among the anthropogenic drivers of climate change, we focus on energy, the dominant actor in the ecological story of climate and health.

The Ecological Life of Dirty Energy. Each energy source has a life story. Those of two fossil fuels – oil and coal – are particularly relevant.

Oil’s story, detailed in a report by The Center for Health and the Global Environment at Harvard Medical School, includes a host of health and environmental impacts: “every stage in the life cycle from exploration to use can have harmful effects on our health and the environment.”⁶ Oil is refined into numerous products, including gasoline, which is burned as fuel for cars, trucks, and sport utility vehicles. Gasoline-powered motor vehicles – “mobile sources” of emissions – produce smog and a potent mix of air pollutants including volatile organic compounds (“VOCs”), soot, benzene, arsenic compounds, formaldehyde, and lead. The US Environmental Protection Agency (EPA) traces half of outdoor air toxics-caused cancers to these mobile sources.⁷ In addition to its role as a fuel, petroleum also serves as the feedstock for much of modern chemistry, a point of significance for climate-environmental health partnerships to be addressed later.

An interesting and new chapter in the oil-and-climate story comes from emerging research on black carbon soot. “Dirty diesel” engines (as well as home use of coal and biomass for cooking and heating, open trash burning, and other sources) emit soot, or blackened particles of carbon material, which then become airborne. Diesel is responsible for more than half of black carbon soot emissions in the US and other Organisation for Economic Co-operation and Development (OECD) countries, and about thirty percent globally.⁸ Research reported recently in leading journals^{9, 10} suggests that black carbon’s role in global warming has been seriously underestimated. The story traces the life of those soot particles, as they warm the atmosphere directly and as they fall on land.

Black carbon warms the atmosphere more, molecule for molecule, than does CO₂.¹¹ However, soot particles only stay in the atmosphere a matter of weeks, whereas CO₂ lasts for decades. This difference is significant because it means that black carbon reductions would have a more immediate global cooling effect than CO₂ reductions, which are absolutely critical yet will take much longer to play out.¹²

Beyond their warming effect, new research points to additional ecological havoc from the soot emissions that fall on Arctic ice and snow. The dark carbon particles change the “albedo” (reflectivity) of these normally white surfaces. Light and heat that formerly bounced off instead is absorbed. Thus, National Aeronautics and Space Administration (NASA) scientist James Hansen and colleagues suggest, “in addition to being a major cause of global warming, soot may directly contribute to near world-wide melting of ice that is usually attributed solely to global warming.”¹³ The ice melt, in turn, accelerates global warming and sea level rise. Some climate researchers – in putting the ice, darkening and atmospheric effects together – suggest that black carbon aerosols may be responsible for as much as one quarter of all global warming observed to date.¹⁴

The soot story hits humans as well. More than 80 percent of Americans live near major diesel emission sites such as highways, factories, construction, and bus and truck depots. Diesel exhaust also is highly hazardous. It includes forty pollutants named under the Clean Air Act and is the single largest source of air toxics cancers in the US. Diesel soot is fine particulate matter associated with a host of respiratory, cardiac, reproductive health, and neurological development concerns. US air quality officials estimate that controlling diesel emissions both “on-road” and “off-road” would prevent over 16,000 premature deaths, over half a million asthma attacks, and more than three million lost work days annually.¹⁵

Coal, like oil, is heavily relied upon as an energy source. More than half of US electricity and about one-quarter of its total energy come from coal. Like oil, coal’s ecological life story involves a wide array of health and environmental problems, including at the front end (associated with mining and transportation) and back end (coal combustion waste disposal).¹⁶

The middle of the story – combustion – is most significant for climate and health. US power plants produce about two-thirds of the sulfur dioxide (SO₂, a respiratory irritant), one-quarter of the nitrogen oxides (NO_x, the main ingredient in ozone smog), and one-third of the mercury (a dangerous neurotoxin) emitted into the air, water, and landfills.ⁱ The SO₂ and NO_x emissions also convert in the atmosphere to fine particles, estimated to cause at least 30,000 premature deaths in the US and hundreds of thousands of asthma attacks, respiratory and cardiac problems. Other toxics found in the emissions from coal-fired plants include dioxins, hydrogen fluoride and chloride, selenium, nickel, manganese, lead, chromium, beryllium and arsenic.¹⁷

ⁱ Due in part to several years of coordinated advocacy, new proposed EPA rules would significantly reduce power plant emissions of NO_x and SO₂ in the next decade (albeit not as deep or as fast as environmental advocates hoped).

Power plants are the leading industrial source of US greenhouse gases, including some 40 percent of CO₂ emissions. Most US coal-fired power plants were effectively “grandfathered” from clean air regulations requiring that existing plants install the pollution control required on more modern plants.¹⁸

The different fossil fuel stories weave together, as these climate-forcing agents interact and produce additional impacts. Pollution from both stationary sources (e.g., power plants) and mobile sources (e.g., motor vehicles) affect air quality. NO_x and VOCs react in sunlight to produce ozone (smog) – another greenhouse gas. Emerging science suggests that methane – by itself a major greenhouse gas – also is a major precursor of ozone. Ozone and its precursors may travel widely, impacting air quality and health far from the sources. Higher temperatures, in turn, are often associated with higher ozone levels.¹⁹ Over half of the US population lives in counties with unhealthy levels of ozone or fine particle pollution, or both.²⁰

Uneven Exposures, Vulnerable Populations. The human health impacts of dirty energy are unevenly experienced. Many pollutants have both local and long range impacts, but communities near emission sources typically bear a greater burden. Some toxics – such as mercury – concentrate in “hotspots” posing significant threats to nearby communities.

Certain populations are disproportionately exposed to the effects of dirty energy. Power plants, bus depots, highways and heavy industry are all more likely to be situated proximate to minority and low-income communities. More African-Americans (67 percent) live near coal-fired power plants than do whites (56 percent); more African-Americans (71 percent) live in counties violating clean air standards than do whites (58 percent). Compared to whites, asthma sends three times as many African-Americans to the emergency room, and kills twice as many. Infants living in areas with dirtier air – disproportionately populated by racial and ethnic minority and low-income communities – have higher rates of pediatric asthma, and higher death rates from illnesses such as sudden infant death syndrome and respiratory problems.²¹

Poor people and people of color who become sick from environmental exposures then enter the world of “health disparities” shaping their access to insurance, access to health care, and the quality of care – all parts of a life cycle of inequity.

If exposures to pollutants and toxins are uneven, so are the vulnerabilities. Many health conditions of the elderly, the poor, and immunocompromised groups are worsened by air pollution and heat stress.

Children are acutely vulnerable to toxic exposures, particularly during certain key periods of development. Children also spend more time outdoors than adults and breathe 50 percent more air relative to body weight than adults.²² A disproportionate share of a child’s lifetime burden of exposure thus occurs during the critical and vulnerable childhood years.²³

Asthma is the leading cause of school absenteeism due to chronic illness. “Hundreds of community health studies have linked daily increases in fine particle pollution to reduced lung function, greater use of asthma medications, and increased rates of school absenteeism, emergency room visits, hospital admissions, and premature death.”²⁴ Recent research also suggests that high ozone levels may be linked, for exercising children, to the *onset* of asthma, not just more asthma attacks for those who already have the condition.²⁵

The Story for Wildlife. Fossil fuels throughout their full life cycle have many serious impacts on wildlife and their habitats. Pipelines carrying oil and gas from points of extraction – and the roads required to build and maintain the pipelines – often fragment wilderness areas. This is particularly problematic for large “charismatic predators” whose survival depends on extensive habitat. Transport also leads to fuel leaks and spills. These are regular occurrences that pollute water ecosystems and kill fish, marine mammals, and birds. In April 2004, a ruptured pipeline that pumps petroleum from refineries in the San Francisco Bay Area gushed 60,000 gallons of diesel fuel into Suisun Marsh, an ecologically sensitive area that serves as a key nesting ground for migratory birds.²⁶

As with humans and climatic systems, it is fossil fuels’ combustion byproducts that may pose the biggest cumulative problem for wildlife. Mercury emissions from power plants, for example, harms both land animals and fish. Mercury emitted into the air wends its way into water systems, and under some conditions converts into its most toxic form, methyl mercury. Methyl mercury “bioaccumulates” up the food chain as big fish eat smaller ones. In some water bodies, fish-eating birds and mammals can accumulate so much mercury that reproduction is compromised.²⁷

The cooling cycles of power plants affect water ecosystems. Millions of fish annually are caught in cooling water intake structures; “thermal pollution” is produced as discharge waters (which may be 30° F hotter than intake waters) are released.²⁸

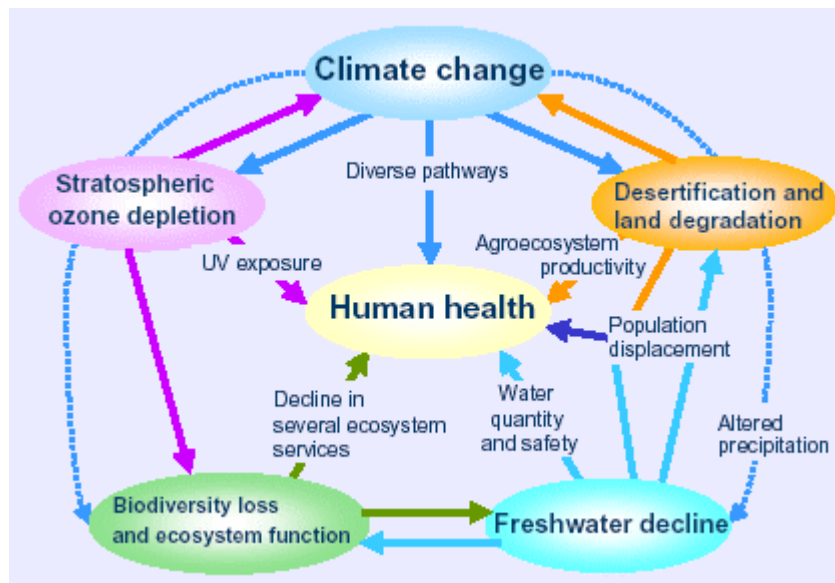
Electric power plants are the largest culprits of “acid rain” (through a process in which SO₂ and NO_x are emitted into the atmosphere and combine with other ingredients to form acidic compounds which then return to the earth in precipitation, gaseous or particle forms). Acid rain may land on terrestrial ecosystems far from the sources of the original pollution, where it damages forests like high elevation spruce firs or sugar maples.²⁹ According to the EPA, in aquatic systems acid rain also “causes a cascade of effects that harm or kill individual fish, reduce fish population numbers, completely eliminate fish species from a water body, and decrease biodiversity.”³⁰

Energy Matters. From an ecological health perspective, the life story of dirty energy merits special attention. Fossil fuel combustion by both stationary and mobile sources is by far the leading driver of global warming. It also is the source of massive air and water pollution associated with many diseases and health conditions, including respiratory, neurological, developmental, cardiac, carcinogenic, and other concerns. It disproportionately affects already-vulnerable communities and habitats. Dirty energy is a shared threat to the health of ecosystems (from local air quality to regional and global climate systems), humans, and wildlife.

HEALTH IMPACTS OF CLIMATE CHANGE

What does climate change mean for ecological health? It is not a simple story. Climate change affects natural and social systems in many ways, and each of them affects health. As the IPCC noted in assessing the state of science on the health impacts of climate, “For scientists, the causation of most of the health outcomes considered ...— from respiratory and cardiovascular disease to various types of infectious diseases — is complex: Various social, technological, demographic, behavioral, and environmental factors influence the risk of occurrence of these diseases.”³¹

Another complication is the fact that we are still shaping the experiment that is climate change. The range, intensity and impacts of climate changes are to a great extent yet to be determined by future choices about energy, land use, development patterns, and transportation. Communities’ vulnerability, or capacity to adapt, will also strongly affect the scope and severity of the health impacts from climate change. It also is hard to predict with certainty the many health impacts likely to be linked to regional climate changes, because of the evolving state of regional climate assessment modeling.³²



Appreciation of large-scale and global environmental hazards and their influence on human health requires a new perspective which focuses on ecosystems and on the recognition that the foundations of long-term good health in populations rely in great part on the continued stability and functioning of the biosphere's life-supporting systems. It also brings an appreciation of the complexity of the systems upon which we depend. – World Health Organization.³³

The following section provides an introduction to issues of climate-health linkages and highlights areas which may be of particular relevance to grantmakers.

Climate & Human Health – An Evolving Science. The international scientific consensus on climate-health linkages is on an accelerating path. The first assessment report of the IPCC (1991) gave little attention to climate-related health concerns. By 1996, the second assessment devoted an entire chapter to potential health risks from climate change.

By its most recent (2001) report, the IPCC concluded that, “Overall, climate change is projected to increase threats to human health, particularly in lower income populations, predominantly in tropical/subtropical countries. Climate change can affect human health directly (e.g., reduced cold stress in temperate countries but increased heat stress, loss of life in floods and storms) and indirectly through changes in the ranges of disease vectors (e.g., mosquitoes), water-borne pathogens, water quality, air quality, and food availability and quality.”³⁴

In 2003, World Health Organization researchers reported that, based on data only for the better-understood health outcomes, climate changes since 1990 already had claimed at least 150,000 deaths in 2000 and an additional 5.5 million years of life lost to premature death or lived with disabilities.³⁵

How are such analyses made? The IPCC noted, “Over the past five years we have acquired better understanding of direct temperature effects on health (heat and cold), temperature effects on air pollutant production, the seasonality of certain infectious diseases, and the public health consequences (and situational modifiers) of extreme weather events. Predictive modeling of how scenarios of future climate change would affect the patterns and impacts of vector-borne diseases has evolved, as has modeling of impacts on regional agricultural yields and the geography of world hunger.”³⁶

Such predictive modeling has also been tested against actual precipitation, temperature, and other data from recent El Niño weather events. El Niño proved to be a rich case study of the complex effects of a climatic change on health, both directly (through drought, flood, and extreme weather events) and indirectly (through infectious disease spread). The 1997 and 1998 events, for example, led to malaria, Rift Valley fever, and cholera outbreaks in Africa, to malaria, dengue fever, and cholera in Latin America, and to fires, respiratory illnesses, and wildlife mortalities in Indonesia. The 1998 La Niña event caused flooding in Bangladesh and China (displacing 230 million people) and in Texas, Hurricane Mitch (killing thousands and sharply increasing disease epidemics), a harsh European cold wave in October, and a severe southern US ice storm.³⁷

The IPCC identified seven **categories of climate’s impacts on health**³⁸:

- **Thermal stress**, including heat waves, cold spells, and decreased mortality from milder winters. Heat waves are “already the largest natural caused killer in the world” and are becoming more frequent and intense. US heat waves increased by 88 percent during the period 1949-1995.³⁹ Europe’s heat waves in the summer of 2003 caused thousands of deaths. In addition to causing heat strokes, heat waves increase smog and allergens, which aggravate preexisting respiratory and cardiac problems.
- **Extreme weather events and weather disasters** such as floods, storms, tropical cyclones, and droughts. One of the most destructive byproducts of climate change, these extreme weather events often have direct health impacts (e.g.,

drowning and injury from floods).⁴⁰ They also trigger chains of events that create more widespread harm. Intense rainfall, for instance, creates standing pools of water in which mosquitoes breed, increasing infectious disease spread. Rainfall events also may lead to flood disasters and to water supplies contaminated with human or animal waste, leading to water-borne illnesses.⁴¹

- **Air pollution**, including changes in air quality and aeroallergens. Weather conditions (climate on a daily or weekly scale) can affect the formation and transport of air pollutants (e.g., sulfur dioxide, ozone, nitrogen dioxide, carbon monoxide, lead, and particulates), as well as the production and distribution of both natural (e.g., pollen) and human-made allergens.⁴² New reports also suggest that the warmer, or positive, phases of the El Niño Southern Oscillation and of the North Atlantic Oscillation both were associated with higher concentrations of persistent organic pollutants (POPs) such as lindane and polychlorinated biphenyls (PCBs) around the Great Lakes.⁴³
- **Infectious diseases** such as malaria, dengue fever, and other mosquito-borne viruses (e.g., leishmaniasis, schistosomiasis, Chagas' disease, plague); tick-borne diseases (e.g., Lyme disease, tick-borne encephalitis); rodent-borne diseases (e.g., leptospirosis, hantaviruses); water-related and other infectious diseases. Climate's impacts on temperature, humidity, rainfall, and rising sea-levels all can affect the transmission of infectious diseases. Warmer temperatures can expand breeding grounds and speed insects' maturation.⁴⁴ Biologists have documented a northward migration of insects and marine life along the Pacific Coast, attributing it to climate change.⁴⁵
- **Coastal water-related health issues**, such as the connections among increasing sea temperatures, plankton blooms, and diseases such as cholera.
- **Food yields and nutrition**. Many staple food crops on which people depend in tropical countries (including large portions of Africa, Asia, and Latin America) already are near their "thermal limits." Their yields may decrease by as much as one-third with climate change, leading to increased hunger and malnutrition.⁴⁶ Cereal crop yields in more temperate countries could increase slightly with small temperature increases, but they too are projected to decrease with even moderate temperature increases.⁴⁷
- **Demographic and economic disruption** when communities are displaced or homes lost due to storms or sea level rise have numerous health effects, including infectious and respiratory diseases, malnutrition, and psychological stress.

As with the drivers of climate change, the health impacts of climate change will fall unevenly on different populations. For thermal stress, for instance, the elderly, children, the poor, and urban residents may be most at risk. Rising sea levels and coastal flooding may hit shoreline and island communities hardest. There also is great variability in the vulnerability and adaptive capacities of various populations to the health impacts of climate change.

Climate change may bring with it some health benefits in certain areas, such as the reduced stress of milder winters. The IPCC reports detail these positive outcomes but conclude that adverse health impacts (across wildlife and humans) outweigh the benefits, and that the net effect will become more negative as the amount of global warming increases.

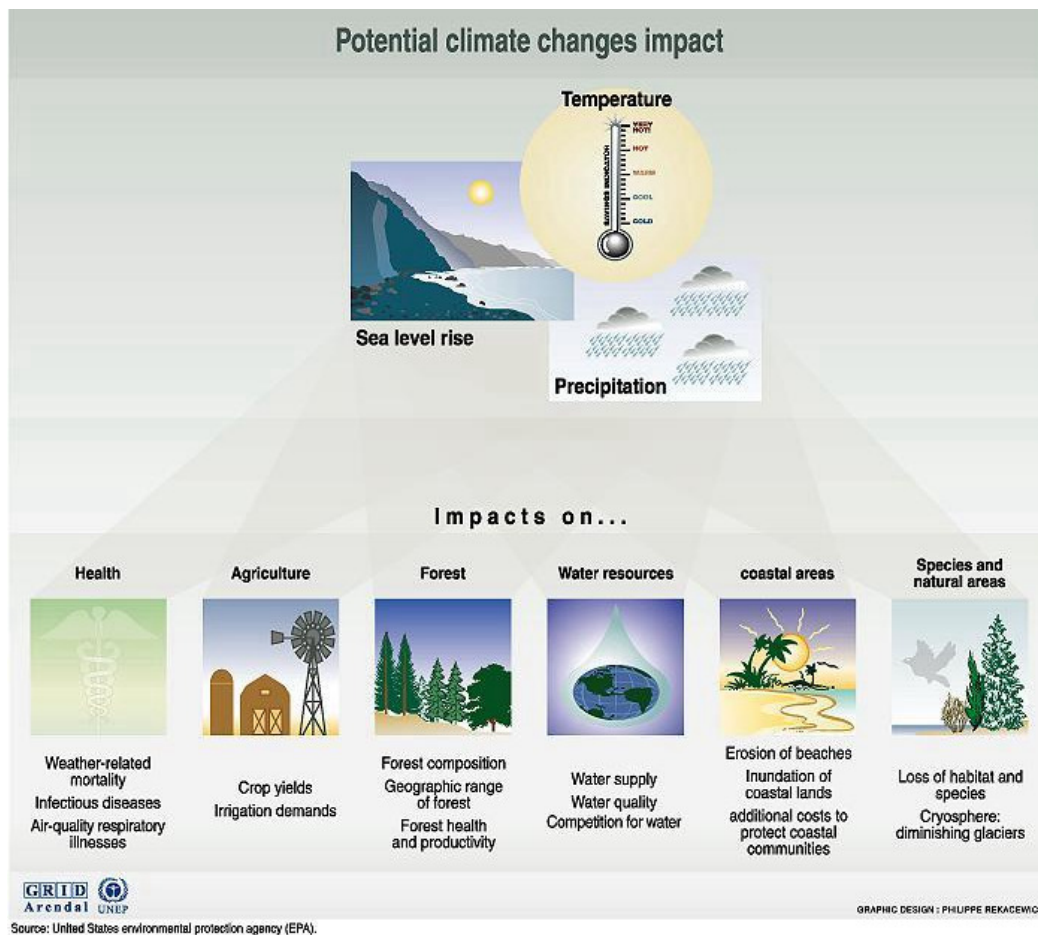
Wildlife Health. Climate changes' effects on wildlife and on biological diversity are as diverse and complex as they are on human health. In many cases, they further exacerbate other destructive forces. Just as human populations that are already health-impaired or vulnerable may be harder hit by climate-driven changes or less able to adapt, so too many species and ecosystems already are under stress from deforestation, habitat loss, and/or toxic exposures.

A large study looking at the ranges of over one thousand animal and plant species in six regions, reported in *Nature* (2004) concluded that as many as 37 percent of those species are at risk of extinction from climate change. The researchers reported that climate changes in the last three decades already have caused “numerous shifts in the distributions and abundances of species”.⁴⁸

Even small fluctuations in temperature can have direct or indirect effects on species' viability. For some species there will not be any climatically suitable habitat; others may not be able to move far enough to find it. Even those species that are able to move may find the more climatically suitable habitat inhospitable for other reasons, such as human land use and development.⁴⁹ Just one example: the melting of sea ice underway in the polar regions is having observable impacts on polar bears that depend on sea ice to hunt seals. Predictions that the polar ice cap may recede, if not disappear, by the middle of this century effectively constitute a death sentence to polar bears (and perhaps for the ecological and cultural systems of which they are a part).⁵⁰

Other climate-related disturbances to ecosystems include:

- **Changes in prey-predator balances.** Climate and the natural systems affected by it help regulate the balance between predator and prey species, as well as the balance among these “functional groups” of species and infectious disease agents like pests and pathogens.
- **A rise in invasive species.** Higher concentrations of CO₂ and other climate-driven changes may expand the range of some invasive plants and animals – both on land and in the water. Invasives often are highly opportunistic, able to expand their habitat or adapt to new ones; they tend to crowd out native species. The European Green Crab, for instance, has moved into numerous coastal communities outside its native ranges. It has been blamed for wiping out the US East coast soft shell crab industry in the early 1950s. Recent research strongly suggests that this invasive crab also moved into the Pacific Northwest waters through larval transport during the 1997-1998 El Niño event's strong ocean currents.⁵¹



Humanity's greenhouse gas emissions are expected to lead to climatic changes in the 21st century and beyond. These changes will potentially have wide-ranging effects on the natural environment as well as on human societies and economies. Scientists have made estimates of the potential direct impacts of climate changes on various socio-economic sectors. Impacts on one sector can also affect other sectors indirectly. – UNEP/GRID-Arendal⁵²

Complex Stories. Human-induced climate change sets in motion complex chains of events that have repercussions for the health of humans, of wildlife, and of ecosystems.

- Scientists doing “bio-complexity” research in Hawaii have found that many native bird species depend on a “safety zone” from avian malaria and other diseases. Temperatures must remain cool enough at certain elevations to kill the protozoa of the malaria-carrying mosquitoes. Temperature increases in the lower parts of the safety zone already are being reported, as are decreased populations of birds. Another climate-endangered check on mosquitoes is the Hawaiian damselfly. The damselfly, which feeds on mosquito larvae, lives in water droplets on water lilies. The researchers predict that global warming will decrease the damselflies’ moisture-based habitat and thus their ability to maintain limits on mosquitoes that transmit avian malaria to birds.⁵³

- The Center for Health and the Global Environment points to connections between climate change and forest fires. Global warming brings milder winters and droughts to some regions. Milder winters kill fewer tree pests like bark beetle larvae and expand the range of bark beetles. Drought interferes with trees' ability to drown beetle larvae in resin. Bark beetles kill trees (up to 80 percent of pine trees in parts of Southern California), and dead trees are more vulnerable to forest fires.⁵⁴ (This combines with the fire risk already arising from human encroachment into forested areas and a long-term fire prevention strategy.⁵⁵) The California forest fires of 2003 burned 750,000 acres, claimed the lives and habitat of many forest-dwelling creatures,⁵⁶ and created particulate and haze pollution, leading to respiratory, cardiac and eye problems for the nearby human populations.⁵⁷
- In Six Modern Plagues and How We Are Causing Them, Mark Walters traces the climatic roots of Hantavirus Pulmonary Syndrome (HPS) outbreaks in 1990 that hit 318 people and killed a third of them. In the 1990s, two El Niño events (which scientists suggest are being intensified by global warming) each produced unusually heavy rainfall in normally arid areas like New Mexico. This extra precipitation brought bumper crops of nuts, seeds, and vegetation eaten by mice. Deer mice populations benefiting from this extravagance increased dramatically. Some of these mice moved into human settlements, carrying HPS to human populations.⁵⁸

The connections from human activity to ecosystem instability to wildlife disease thus may affect human health. Habitat loss, declining biological diversity and a changing and unstable climate all contribute to the emergence and spread of diseases from insects, rodents or wildlife to humans. We need much better understanding of the pathways between climate change and disease. Already, however, the emergence of environmentally sensitive diseases such as virulent strains of malaria, Lyme disease, Hantavirus Pulmonary Syndrome, and West Nile encephalitis are of growing concern.⁵⁹

Put simply, natural systems, wildlife, and humans share so many pathways that a health threat to one often becomes a health threat to others.

Other Complexities

One such shared health threat is dirty energy. It is having massive, adverse impacts on all three dimensions of ecological health, and tackling it would have huge health benefits. Beyond those simple truths lie more complexities.

For one thing, the *alternatives* to the dirty energy economy will also have ecological costs and impacts. The ecological health frame suggests evaluating these tough policy choices holistically. For example, wind power is often at present the most economically competitive renewable energy source. However, wind farms have met with steep resistance from some environmentalists concerned with preservation of natural vistas or bird mortalities. From an ecological health perspective, one would assess wind turbine

threats to individual birds (noting that mortalities have declined with improved designs) alongside multiple-species-wide extinctions likely to occur with climatic change. (These, as detailed in *The Birdwatcher's Guide to Climate Change*, include changes in range, migratory patterns, habitat, and food availability, with greater survivability threats to birds highly dependent on specific habitats or already weakened by other environmental stressors.)⁶⁰

Also, many climate-driven health impacts in this century may be unavoidable. Even with much more aggressive greenhouse gas reductions than are currently being pursued, CO₂ already emitted will continue to drive climatic changes because of its long atmospheric lifetime (about a century). We can say that tackling CO₂ emissions is vital for the climate and for ecological health over a long time span. We cannot say that it will, by itself, avert health impacts from climate change in our lifetimes. Nevertheless, there are many areas where information is solid and solutions are available which would benefit climate and health immediately. Both short-term and long-term opportunities are available and should be pursued.

DEFENSE OF HEALTH: OPPORTUNITIES FOR FUNDERS

The climate-health story illustrates starkly the destructive potential of human interdependence with the natural world. Yet this interdependence could also be used constructively.

Health Messages and Messengers: Public opinion polls and focus groups consistently find that people care a great deal about threats to human health, clean air and clean water. Well-tested messages framing environmental concerns – such as power plant emissions or climate change – around health often are quite powerful. Use of a health frame can also help build bipartisan or nonpartisan support. From the Vote Solar bond initiative in San Francisco, to a Massachusetts campaign to tighten pollution controls in power plants, to the current national debate over mercury emissions from power plants, advocates are gaining ground by providing credible information about the health costs or benefits of different policy choices. Grants from the Pew Charitable Trusts in several of these arenas have supported high-quality analyses of health impacts and their translation into public education messages and materials

Polling and focus group work also have found that doctors, nurses, and public health professionals are highly trusted messengers. A press conference organized by Physicians for Social Responsibility advocating stricter mercury emission controls at power plants put pediatricians front-and-center to talk about the neurotoxic effects of mercury on children's development. Similarly, health-affected groups – who are becoming better organized and more vocal on environmental exposure issues – can be highly effective messengers. The John Merck Fund is among the grantmakers supporting the engagement of health professionals and health-affected groups, along with advocacy groups skilled at supporting these health messengers in media work.

One lesson emerging from this work is the need for more genuine partnerships and reciprocal relationships between health professionals and environmentalists. The importance of avoiding an opportunistic “rent-a-doc” approach was underscored at a Beldon Fund-supported meeting in 2004 on ways to better engage the nursing community in environmental health.

Much effective work at the intersections of climate, energy and health has come from environment-health partnerships. For example, the Massachusetts campaign to clean up the “Filthy Five” power plants, which resulted in the first state imposition of four-pollutant (4P) emission standards paired environmental and public health advocates with authoritative health impacts analyses done by the Harvard University’s School of Public Health. A “Sooty Six” campaign in Connecticut similarly used health messages and messengers to clean up power plant emissions. Such partnerships can offer resonant messages, delivered by credible messengers, and take advantage of the strengths of different communities, from environmentalists’ hard-hitting activism to academics’ roles as “science validators.”

Other innovative efforts to build effective messengers on climate change include the National Environmental Education and Training Foundation (NEETF)’s work with the Weather Channel for its coverage of climate issues, and the Pew Climate Center’s work with major corporations willing to publicly affirm concern about climate change.

Other relevant lessons on climate “framing” came from the joint investments of several funders in a Frameworks Institute project, which strongly advocated pairing messages about the problem of climate change with information about doable solutions. The implication for climate-health work: present information on health impacts in the context of what can be done.

FUNDER STRATEGIES

Leverage Research. Grantmakers could help leverage governmental funding in important areas, and themselves fund smaller but critical pieces of research. Big informational gaps remain on emerging issues such as: on linkages between climate change and the spread of infectious diseases; on black carbon impacts on global warming and on health; on the relationship between methane reductions and ozone concentrations; on strategies to adapt, mitigate, and defend public and wildlife health amidst climate changes; and on the potential climate and ecological health implications of advanced fossil energy systems (e.g., coal gasification), carbon capture and geologic sequestration. In many cases federal funding for this kind of research is critical but is getting scarcer.

Support Climate-Health Information and its Champions: Funders could advance the field by supporting more “translational” information on climate-health linkages to help make the case for climate-friendlier policies to unknowing stakeholders. Credible, accessible information is needed about the impacts of dirty energy and of climate change on specific communities and sectors. Information also is needed about the health and other benefits of cleaner air and clean energy.

Grants from the Pew Charitable Trusts, for example, enabled the Clear the Air campaign to commission an “Air of Injustice” study of the disproportionate impacts of dirty power on minority communities, and to use this data in outreach to new community champions. The Beldon Fund has supported the Clean Air Task Force and its grassroots partners, including local Lung Association chapters, in Atlanta, New Haven, Chicago, and Detroit for a project on dirty diesel. This project partners local activists with area academics. In some neighborhoods children were equipped with backpack air monitors to gauge emissions on and off the school bus. This highly local data about diesel emissions was then used to inform Parent-Teacher Associations, public health professionals, parents and the public, and to catalyze support for funding of diesel bus retrofits and cleaner fuels.

The National Institute of Environmental Health Sciences (NIEHS) has funded several community-based participatory research projects on pollution and health. These projects pair academic researchers with community organizations (e.g., West Harlem Environmental Action and Columbia University work on bus routes and asthma rates) to produce research that is highly relevant to the environmental health needs of communities.

A Clean Energy Strategy is the Best Defense of Health. A clean energy strategy seeks to reduce greenhouse gas emissions and other climate forcing agents such as black carbon aerosols and tropospheric ozone. The strategy includes promotion of energy efficiency (the “fifth fuel”), much stricter controls on stationary and mobile sources of emissions, and an accelerated move towards renewables.ⁱⁱ

Within a clean energy strategy, human health arguments may be particularly effective in advocacy for black carbon aerosols, nitrogen oxides, VOC’s and methane. “[T]hese reductions can also play a significant role in limiting future global warming, because they benefit climate immediately when they are reduced due to their shorter atmospheric lifetimes when compared to CO₂.”⁶¹

Find your Niche. There are funding opportunities at all levels. Community foundations and other place-focused grantmakers can support policy solutions and constituency-building at the municipal, state, and regional levels. Hundreds of cities and a number of states have climate plans in development, with much needed for support of further adoption and implementation.

Critical regional efforts include the New England Governors/Eastern Canadian Premiers’ agreement, the new West Coast Governors/Western Canadian Premiers’ agreement, and a Northeast/Mid-Atlantic trade-regime building. The Energy Foundation and others are supporting such regional efforts – and strategic linkages among them through the Climate Action Network – both for their emission reduction potential and as building blocks for a more constructive US federal approach.

ⁱⁱ The policy agenda includes: efforts on mandatory greenhouse emission reductions, power plant regulations, diesel clean-up mandates for the existing fleet, opposition to siting of new conventional coal plants, fuel efficiency standards, appliance standards and other energy efficiency policies, Renewable Portfolio Standards, state and federal support for renewables (e.g., wind, solar, biomass, wave power, hydrogen), transportation policies and their impacts on vehicular miles traveled (VMTs), subsidies for fossil fuels.

There is a wide array of national and international opportunities, including the promotion of policy solutions, constituency-building, and a range of sector-targeted strategies such as market and investor campaigns.

Focus on Strategies with Multiple Benefits. Given the limited philanthropic assets in this field and the urgency of the problems, it is critical that grantmaking be strategically targeted to areas that bundle environmental and health gains. Approaches, which highlight both climate and health stakes (and, in many cases, economic and other interests as well) are most likely to be successful, and at the scale and in the timeframe needed.

For each community a different mix of these bundled messages and multiple messengers will work best. Approaches should be tailored to the particular needs and strengths of the community and the various stakeholders

The Emily Hall Tremain Foundation has pursued climate-health “bundling” strategies in several ways, including support for: Environment Northeast for its work on a Connecticut Clean Diesel initiative; the Connecticut Fund for the Environment to study emission exposures of Connecticut communities living or working closest to highways, linked to a Smart Cars – Clean Air initiative; and broader efforts to develop a Connecticut state action plan on climate that embeds health issues and stakeholders as integral parts of the strategy.

The US power plant campaigns, supported by the Pew Charitable Trusts and others, also have used bundling strategies effectively. Here, clean air advocates are using compelling data on the health impacts of conventional pollutants (e.g., SO_x, NO_x and mercury) to push for a comprehensive “4P” approach to regulate both climate-threatening CO₂ and air pollutants. Current debates on mercury regulations, similarly, begin with a health message to advance shared concerns over the health and climate impacts of the coal-fired power plants.

Similar “smart-bundling” approaches could be useful. A diesel strategy could highlight the twin health-climate threats, and focus on communities most at risk from dirty diesel and/or in regions where reductions in black carbon emissions would most significantly reduce transport to polar ice sheets. (An important research need here is to identify communities whose diesel exposures have the most impact on Arctic soot deposition.)

An ozone strategy might include efforts to reduce methane as well as NO_x and VOCs, for maximum climate-health benefit.

Beyond climate and health co-benefits, several of the most important clean energy strategies offer other co-benefits as well. For instance, energy efficiency yields significant cost savings. Much of the impetus for renewables development lies in job and new markets/products creation. Smartly-bundled strategies will focus on climate-critical issues, detail health and other costs of business-as-usual and highlight the gains from alternative paths.

That being said, advocates working at different levels need some flexibility to find what policy initiatives, advocacy strategies and tactics by region and circumstance. Policies and strategies that may be successful in coastal states with mainly natural gas and nuclear energy, for example, may not work in coal-dependent states.

Work Collaboratively, and Support Collaborative Work. Most foundations function as autonomous institutions, responsive to their trustees and mission. Effective responses to the complexity, scale, and urgency of the climate problem require a different level of strategic collaboration.

For many funders, climate change may be of concern but not necessarily an apparent fit with their portfolios or areas of expertise. Working within collegial regional, national or international funder networks can enable individual funders to find their “climate” niche within the mission, culture and strength of their foundation. Working in community also helps funders craft effective collective responses – by sharing information, finding synergies among issues and constituencies, and, where appropriate, pooling resources to fund key campaigns.

Many partnerships and collaborations already exist or are in formation, involving environmentalists, public health, environmental justice, medical, health-affected, and other communities. These often have arisen out of work on a specific concern such as clean air standards but could be broadened and deepened to support longer-term climate-health objectives. Funders can help build climate-health alliances both by grantmaking and by using their convening capacities. Local or regional “climate summits” that effectively integrate health and other interests could help cross-educate and build relationships among diverse stakeholders. Place-focused convenings also are critical to contextualize the issues and appropriate solutions.

The following is a brief overview of entry points for partnership between climate and energy funders and others.

Climate, energy, and environmental health: many collaborative opportunities exist:

- Clean air partnerships, including with a focus on mercury, diesel, and the range of health impacts linked to fossil fuel combustion. Health-focused messages and solutions-oriented environmental policy “asks” are gaining real traction. They need more support.
- Environmental justice and health disparities. The data on disproportionate exposures of low-income communities and especially on communities of color is compelling. Strategies that use these data to mobilize and build capacity within affected and vulnerable communities would be useful. So would broader efforts to build alliances among environmental justice and health groups with groups working on health disparities. In a world of climate instability, issues of vulnerability, adaptive capacity and equity will become more critical.

- Heightening awareness, especially in the environmental community, of the importance of a robust public health infrastructure. Environmental health funders have long supported the strengthening of health tracking systems – to monitor chronic diseases in order to match health outcome data with chemical/toxics exposure data. From a climate perspective, health tracking also is needed to monitor infectious diseases in order to create baseline data for assessing climate change impacts. Funders could help link health and climate stakes in a stronger public health infrastructure, as the first line of defense in coping with an array of assaults on health.
- Market campaigns and work with industry. Both the environmental health and climate/energy communities are developing significant capacity in market campaigns, investor/shareholder work, and cultivation of industry allies. Given that petroleum is both fossil fuel and primary feedstock for modern chemistry, there are potential synergies among some corporate-focused efforts to be explored. Sharing models of success around building sources and markets for alternatives, whether it be “green” energy or “green” chemistry, might also lead both to useful lessons on both sides and some new business-labor-civil society alliances.
- Litigation. Past experience with tobacco litigation increasingly is informing work underway in both the environmental health and climate/energy fields. Some synergies of strategy, and relationships with key actors such as state attorneys general, could be explored. Litigation also may provide an additional revenue source for climate-health work. Community groups in the San Francisco Bay area that settled a lawsuit based on regional quality regulations and the federal Clean Air Act asked that the settlement awards go to The San Francisco Foundation, which then matched the settlement with its own resources and regranted these funds in support of improved air quality and health in those highly impacted communities.
- Green building and healthy schools. Both the climate/energy and environmental health communities share interests in buildings that are healthy both for the environment and for their occupants. The Henry P. Kendall Foundation is promoting the design and construction of high performance/healthy new public schools and major school renovations throughout New England states and provinces of Atlantic Canada. Anticipated returns from these investments include higher student classroom performance and attendance levels – as well as energy savings and climate benefits.
- Shared principles. Some fundamental principles guiding work in the environmental health arena are of growing interest in the climate context as well. These include the Precautionary Principle, “polluter pays”, community “right-to-know,” and substitution/safer alternatives. Funders could help build a shared knowledge base, not only of the intellectual work on these principles, but also of the models and champions of successful implementation in the policy and market arenas.

Smart growth: Smart growth strategies offer many “win-win” opportunities. Smart growth increasingly is of interest to health funders concerned about obesity and physical activity. Smart growth and transportation strategies also are critical to climate in terms of increasing energy efficiency, reducing vehicular miles traveled, maintaining public health capacity, preserving green space and “carbon sinks.” Climate change also poses new challenges for land use, including exacerbation of urban “hotspots” and urban allergens, and the possibility that a decentralized “clean energy” economy could exacerbate sprawl. Translation papers produced by the Funders Network on Smart Growth and Livable Communities – on such issues as smart growth and health, and smart growth and energy – are useful resources.

Biological diversity and conservation medicine: Climate change poses critical threats to the health and survivability of many individual species and of biodiversity. The developing field of conservation medicine has important contributions to make in understanding these changes and in tracing links between emerging diseases in wildlife and their potential spread to human populations. Funders focused on preserving specific species or wilderness areas could fund the development and dissemination of information on climate impacts in these areas, as a way of spurring policy changes and in looking at options for adaptation.

Rural economic development and sustainable agriculture: Several of the most promising clean energy technologies (e.g., wind power and biofuels) offer not only health co-benefits but also substantial opportunity in terms of rural economic development and supplemental farm income. The Garfield Foundation has engaged several funders and leading non-governmental organizations in an assessment of renewable energy as a vehicle for sustainable development in the US Midwest. Farmers and rural communities interested in organic and sustainable agriculture (concerned about occupational exposures to agro-chemicals) increasingly are interested in the economic potential of renewable energy. Funders supporting sustainable agriculture have an important role to play in integrating their objectives into the rapidly emerging interest in biomass. Bio-based chemistry may be another arena for interesting synergies among sustainable agriculture, environmental health, and clean energy communities.

Jobs and technology: In both rural and urban areas, organizing is focused on health and economic benefits of clean energy technologies. Existing efforts should go farther to engage labor, venture capitalists, and others around the jobs and wealth-creation potential involved in upgrading the electrical grid and other energy efficiency and renewable technologies efforts. The Energy Future Coalition (supported by the Turner and United Nations Foundations), the Apollo Alliance (supported by the Nathan Cummings Foundation and others), and regional climate groups in the Pacific Northwest, Midwest and elsewhere are involved. Emerging relationships and strategic campaigns among labor, environmental health groups and fence-line communities around “safe jobs” issues could provide additional allies and ideas.

To further these collaborations, efforts to strengthen the Climate & Energy Funders Group and its partnerships with other funder groups could be usefully accelerated. Development of collaborative capacity in funder networks at the regional and global levels also is needed.

CONCLUSION

The various elements of a climate-health strategy would tangibly improve health now, strengthen precautionary action against future climate-caused health impacts, and build powerful constituencies for healthy communities and ecosystems. Many different funders have both motive and opportunity to participate in such a strategic collaboration. All the ingredients of success are at hand: evidence of current and future harm from business as usual; the potential for “win-win” partnerships, broad benefits and many co-beneficiaries of an alternate path; and an expanding base of credible science, mobilized communities, and skilled advocates with which to work.

The ecological health frame reminds us of the connections and synergies linking the health of humans, wildlife, and ecosystems. Within this picture, humans are both quite powerful, able to set in motion chains of events with wide ecological repercussions, and themselves very vulnerable to those ecological changes. We can just as surely use the fact of interconnectedness to set in motion chains of events that lead, not to ecological destruction and disease, but to cleaner air and water, a more stable climate, and healthier diversity of life on earth.

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